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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Klaus Doebbeling et al.

Application No.: **10/725,565**

Filing Date: 3 Dec. 2003

Title: COMBUSTION SYSTEM

Art Unit: [to be assigned]

Examiner: [to be assigned]

Atty. Ref. No.: 003-100

SUBMISSION OF CERTIFIED COPY OF APPLICATION IN SUPPORT OF A CLAIM FOR PRIORITY UNDER 35 U.S.C. § 119

Commissioner For Patents
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Sir:

Applicant submits herewith a certified copy of the prior application identified below, in support of a claim for priority under 35 U.S.C. § 119 in the above-identified patent application:

Country	Priority Document Appl. No.	Filing Date
GB	0228319.0	4 Dec. 2002

Prompt acknowledgment of this claim and submission is respectfully requested.

Respectfully submitted,

Date: 22 Dec. 2004

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10/725,565

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Dated 26 November 2003

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Patents Act 1977
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P01/7700 0.00-0228319.0

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-4 DEC 2002
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Cardiff Road
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1. Your reference GBP85719

2. Patent application number (The Patent Office will fill in this part) 0228319.0

3 Full name, address and postcode of the or of each applicant (underline all surnames)

ALSTOM (Switzerland) Ltd,
Brown Boveri Strasse 7/699/5
CH-5401 Baden
Switzerland

04 DEC 2002

Patents ADP number (if you know it) 8257186005

If the applicant is a corporate body, give the country/state of its incorporation: Switzerland

4. Title of the invention A Burner

5. Name of your agent (if you have one)
"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Marks & Clerk
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Patents ADP number (if you know it) 18001

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Country	Priority application No (if you know it)	Date of filing (day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing (day / month / year)

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a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
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See note (d)) Yes

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Continuation sheets of this form	0
Description	5
Claim(s)	1
Abstract	1
Drawing(s)	3 → 3

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Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	
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Request for substantive examination (Patents Form 10/77)	
Any other documents (please specify)	

11. I/We request the grant of a patent on the basis of this application.

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Date: 4 December 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

GB Patent Filings
0207 400 3000

A Burner

The present invention relates to a burner for generating a hot gas, and in particular to a pre-mix burner connectable to a combustion chamber.

Many gas burners rely on swirling to produce efficient mixing of reactants. However, interaction between the complex flow patterns within the swirling fluid and acoustic resonant modes in the combustion chamber can lead to undesired thermoacoustic pulsations or vibrations. These pulsations are associated with coherent vortical flows in the combustion chamber. The vortical flows introduce periodicity into the mixing process, which may lead to periodic heat release and resonant coupling with the combustor acoustic resonant modes. Vortical mixing of the reactants also tends to be limited to large scale mixing with the result that mixing in regions between vortices in the vortical flow tends to be poor.

Thermoacoustic vibrations are problematic in combustion processes, since they can lead to high-amplitude pressure fluctuations, as well as to a limitation in the operating range of the burner in question and to increased emissions from the burner. Many combustion chambers do not possess adequate acoustic damping to account for such thermoacoustic vibrations.

In conventional combustion chambers, the cooling air flowing into the combustion chamber acts to dampen noise and therefore contributes to the damping of thermoacoustic vibrations. However, in modern gas turbines, an increasing proportion of the cooling air is passed through the burner itself in order to achieve low emissions. The cooling air flow within the combustion chamber is thus reduced, resulting in reduced damping of the thermoacoustic vibrations in the chamber.

Another method of damping is the coupling of Helmholtz dampers in the combustion chamber, preferably in the region of the combustion chamber dome or in the region of

the cold air supply. However, such dampers require a considerable amount of space in order to allow them to be accommodated in the combustion chamber. Since modern combustion chambers tend to be relatively compact, it is usually impossible to incorporate Helmholtz dampers in the combustion chamber without substantial re-design of the chamber.

A further method of controlling thermoacoustic vibrations involves active acoustic excitation. In this process, a shear layer which forms in the outlet region of the burner is acoustically excited. A suitable phase lag between the thermoacoustic vibrations and the excitation vibrations makes it possible to achieve damping of the combustion chamber due to the superimposition of the vibrations and the excitation. However, a considerable amount of energy is expended in generating such acoustic excitation.

A further means of providing damping in the combustion chamber is to modulate the fuel mass flow in the burner. Fuel is injected into the burner with a phase shift relative to measured signals in the combustion chamber so that additional heat is released at a minimum pressure . This reduces the amplitude of the thermoacoustic vibrations. However, this technique also leads to high emissions due to the increased fuel.

A further alternative is to inject air into the burner via nozzles to disturb and break up the vortical flow. However, the required additional pipes and plumbing complicates the design of the combustor. Furthermore, the required additional air flow reduces the overall efficiency.

In a similar technique, the vortical flow is broken up by baffles which are located inside the burner in order to disturb the vortical flow. However, the inclusion of such baffles increases the constructional outlay of the burner, which is disadvantageous.

An object of the present invention is to provide a burner in which the above disadvantages are overcome.

The invention provides a burner for a heat generator, the burner being connectable to a combustion chamber by means of an outlet, wherein the outlet comprises a step in the direction of flow of fluid in the burner so as to create turbulence in the fluid flow.

In a preferred embodiment of the invention, three to five steps, and preferably four, are provided in the outlet.

The invention will now be described in detail with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view of a burner according to the invention attached to a combustion chamber;

Figures 2a and 2b are graphs showing the effect of the invention on pressure fluctuations.

In Figure 1, a heat generator has a burner 1 with a swirl generator 2. The swirl generator 2 generates a swirl 3 with an axial flow component facing toward a downstream burner outlet 4. Mixing takes place in an area 5 of the generator 2, so as to ensure adequate mixing of fuel and combustion air. The axial flow cross-section of the area 5 widens in the direction of the outlet 4; this configuration facilitates attainment of a constant swirl 3 in the area 5 with an increasing combustion air mass flow in the direction of the longitudinal axis B of the burner 1. The generator 2 comprises two hollow partial cones (not shown) arranged offset to one another. The offset of the respective centre axes of the partial conical bodies creates two tangential air channels 6. A combustion air flow 7 flows, with a relatively high tangential velocity component, through the two tangential channels 6 into the area 5, thus generating the swirl 3. Fuel is introduced into the burner 1 via a fuel inlet 8 in the form of a nozzle.

The burner 1 is attached to a combustion chamber 9 via an outlet 10 through which the swirl 3 passes. The swirl 3 contains vortical flow, which causes flow instabilities including thermoacoustic vibrations which result in low performance of the combustion chamber.

The outlet 10 is provided with a series of steps 11, 11a and 11b. The steps 11, 11a and 11b induce multiple inflection points into the swirl 3 as a result of the sudden change of velocity of the flow at the steps 11, 11a and 11b. Multiple sources of turbulence are thus formed. This increased turbulence serves to break up the existing vortical flow in the swirl 3, thus stabilising the flow. As a result the performance of the combustion chamber 6 is improved. Furthermore, the increased turbulence results in better small scale mixing. It should be noted, however, that emissions are not noticeably increased as a result of the increased turbulence.

The preferred range of the ratio of the length to the height of the steps 11, 11a, 11b is 1:1 – 7:1, but can be as large as 10:1. The number of steps depends on the expansion ration at the outlet 10, on the re-attachment length, and the selected length to height ratio. The number of steps is usually between three and five. However, one single step can be effective. This is particularly so, if the step height is the same as the amplitude of the dominant vortices.

Figure 2a shows the effect of the burner according to the invention on pressure fluctuations according to variation in Lambda number. Line 12 is effectively a baseline, i.e. it represents a burner which has not been modified in any way. Line 13 represents a burner having steps 11, 11a and 11b with a length to height ratio of 1:1. Line 14 represents a nozzle with extended steps, i.e. steps extended beyond a recirculation zone. This configuration can lead, however, to a destabilisation in combustion.

Figure 2b shows the effect of the burner according to the invention on pressure fluctuations according to variation in power. Line 12a is effectively a baseline, i.e. it represents a burner which has not been modified in any way. Line 13a represents a burner having steps 11, 11a and 11b. Line 14a represents a burner with extended steps.

It will be appreciated that variations of the embodiment described above are possible. Alternative configurations of pre-mix burners are well-known to persons skilled in the art. Similarly, it would be possible to replace the conical swirl generator 2 with a cylindrical swirl generator. It is also known to arrange a displacement body, tapering

towards the outlet 10, inside the swirl generator; this could provide a further alternative embodiment of the invention.

The number and depth of the steps could also be varied.

CLAIMS:

1. A burner for a heat generator, the burner being connectable to a combustion chamber by means of an outlet, wherein the outlet comprises a step in the direction of flow of fluid in the burner so as to create turbulence in the fluid flow.

2. A burner as claimed in Claim 1, wherein three to five steps are provided.

3. A burner as claimed in Claim 1 or 2, wherein four steps are provided in the outlet.

4. A burner as claimed in any one of the preceding claims, wherein the length to height ratio of the steps is from 1:1 to 10:1.

5. A burner as claimed in Claim 4, wherein the length to height ratio of the steps is from 1:1 to 7:1.

6. A burner as claimed in any one of the preceding claims, wherein the outlet is in the form of a nozzle.

7. A generator having a burner as claimed in any one of the preceding claims.

ABSTRACT

A Burner

A burner 1 for a heat generator, the burner 1 being connectable to a combustion chamber 6 by means of an outlet 10, wherein the outlet 10 comprises a step 11 in the direction of flow of fluid 3 in the burner 1 so as to create turbulence in the fluid flow.

(Figure 1)

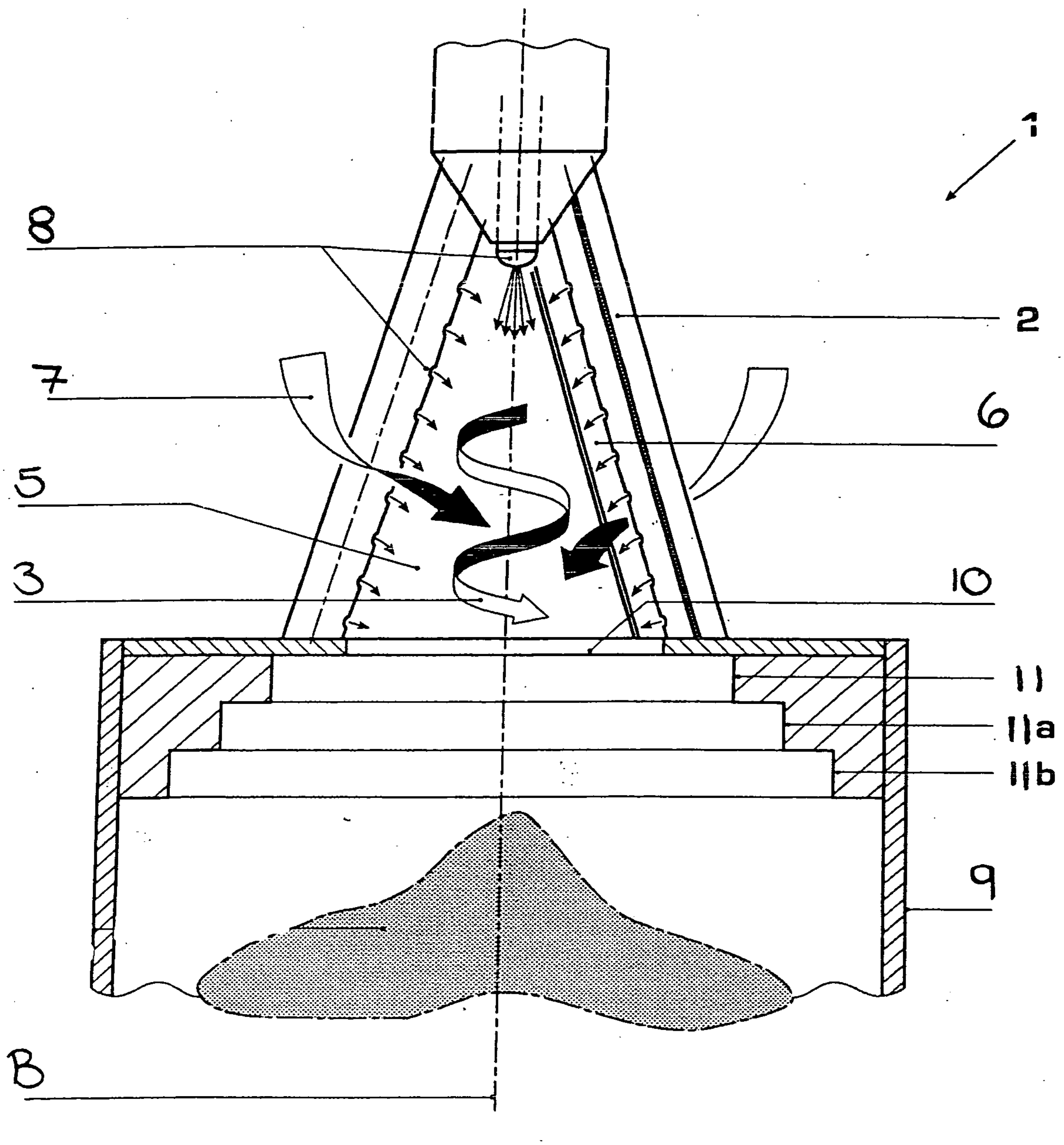

Fig. 1

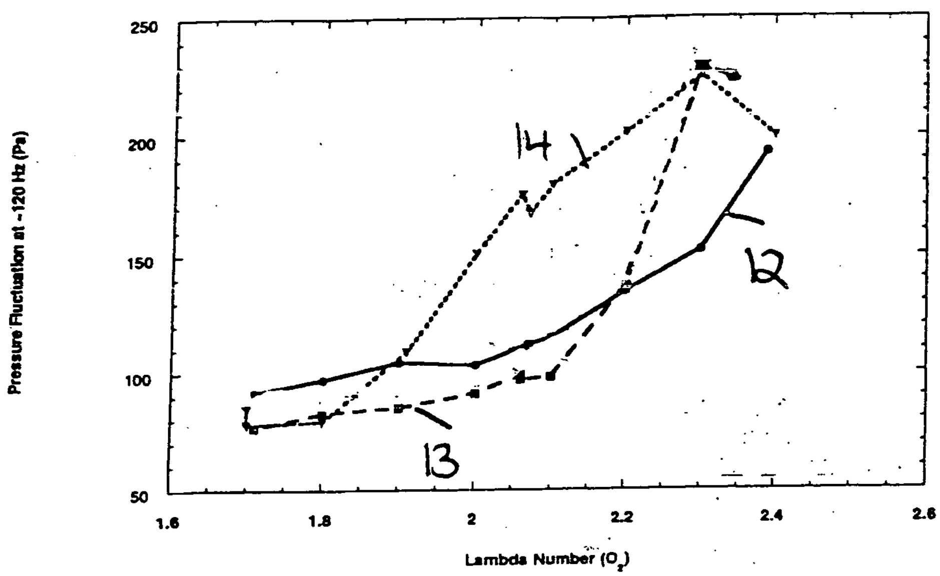
250
200
150
100
50
1.6
1.8
2
2.2
2.4
2.6
Pressure Fluctuation at ~120 Hz (Pa)
Lambda Number (O_2)
14
12
13

Figure 2a

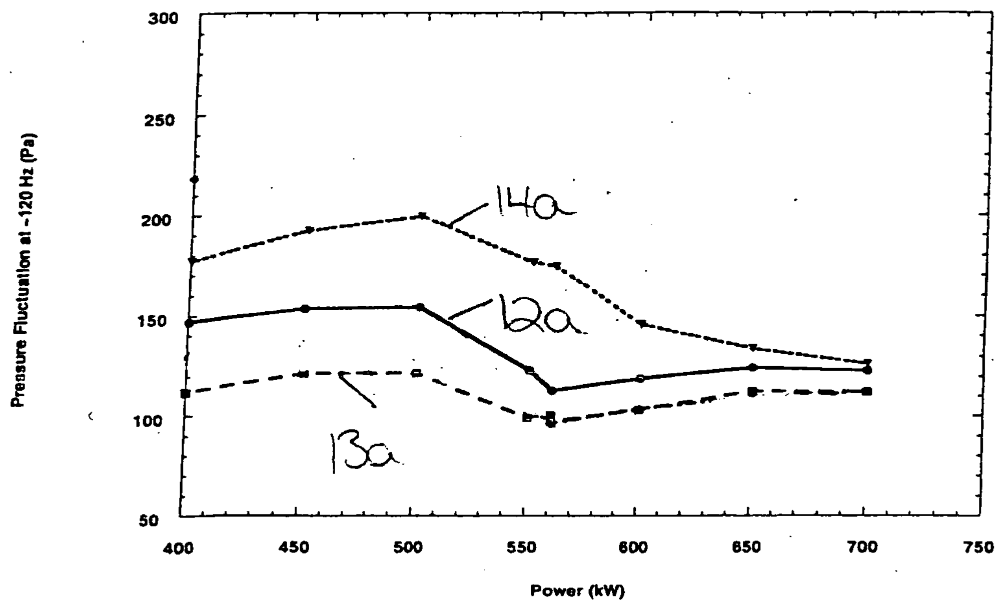
300
250
200
150
100
50
Pressure Fluctuation at ~120 Hz (Pa)
400
450
500
550
600
650
700
750
Power (kW)
14a
12a
13a

Fig. 2b